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The effects of scenarios on judgmental demand forecasts and the subsequent production decisions

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Overview

- Forecasts and Production Decisions
- Judgmental Forecasts and Cognitive Biases
- Research Focus
- Research Design
- Findings
- Discussion

Forecasts and Production Decisions

- Forecasts are designed to support decisions.

- Production decisions
  - How much to produce of each of a ***number of products*** when constrained by ***manufacturing capacity***

- Forecasts for production decisions
  - Point forecasts ⇨ to predict the central tendency
  - Interval forecasts ⇨ to predict variability

- These forecasts allow
  - Setting **safety stocks** levels to prevent **stock-outs**
  - Achieving desired **customer service levels**

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Forecasts and Production Decisions

- In production planning, managers likely access
  - *time series information* on **past demand**
  - *contextual information* relating to **demand**
    (Fildes et al. 2009; Fildes et al. 2018)

- The contextual information may take the form of **scenarios**
  - Scenarios are *powerful tools* that suggest possible future events
    (Godet, 1982; Goodwin and Wright, 2001)
  - Scenarios challenge managerial thinking and support strategic planning
    (Schnaars & Topol, 1987; Schoemaker, 1993; Önkal et al., 2013)

- The forecaster will have the task of ***integrating*** these two types of information to generate forecasts ⟹ production decisions

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Judgmental Forecasts and Cognitive Biases

- Such forecasts and the subsequent production decisions are often based on **management judgment**
  (Sanders and Manrodt, 2003; Fildes and Goodwin, 2007)

- These judgmental forecasts are often inaccurate due to many *cognitive biases* (Lawrence et al., 2006)
  - Most *recent* observations may be overweighted
    (Bolger and Harvey, 1993; Lawrence and O'Connor, 1992)
  - *Judgmental intervals* tend to be too narrow, underestimating the variability
    Overconfidence or **hyperprecision**
    (Arkes, 2001; Soll and Klayman, 2004; Önkal et al., 2009: Moore et al., 2015)

Judgmental Forecasts and Cognitive Biases

- **Scenarios** may help with problems due to these **cognitive biases**, especially <u>overconfidence</u> (Lawrence and Makridakis, 1989: Wright & Goodwin, 2009)

- Alternatively they *may not affect* <u>overconfidence</u> at all
  - *Middle ground scenarios* may <u>divert attention</u> from *extreme possibilities*
  - *Optimistic* scenarios may be preferred over *pessimistic*

(Schnaars and Topol, 1987; Newby-Clark et al., 2000)

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Research Focus

- Scarcity of research

on the *interaction* between **scenarios** and **time series information** and its effects on

  - **forecasts**
  - in particular, the **production decisions** that follow

- This study aims to fill that research gap

  whether the availability of **best and worst-case scenarios** alongside **time series information** enhances or reduces the accuracy of **demand forecasts** → the **subsequent production decisions**

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Research Design

- Participants (68 in total) were given time-series plots showing past demand over the previous 20 weeks for *six products*
- For *each* product, they were asked to
  - make a point forecast
  - give their confidence (probabilistic estimate) that the realized value would be within ± 5% of their point forecast
  - make a production decision (i.e., decide on how many units they would order for production for a particular product)

- This represented an important decision that required them to *translate* their forecasts (and confidence in these forecasts) into actual action

  given that the **total production capacity** was set to a **fixed value** (number of products x baseline demand)

Research Design

- Participants were *randomly* assigned to:
  - **Group 1 – No scenarios**
    (23 participants)
    - the time-series information only
  - **Group 2 – Both weak optimistic and weak pessimistic scenarios**
    (23 participants)
    - the time-series information,
    - weakly optimistic and weakly pessimistic scenarios
      (entitled as "Scenario A" and "Scenario B")
  - **Group 3 – Both strong optimistic and strong pessimistic scenarios**
    (22 participants)
    - the time-series information
    - strongly optimistic and strongly pessimistic scenarios
      (entitled as "Scenario A" and "Scenario B")

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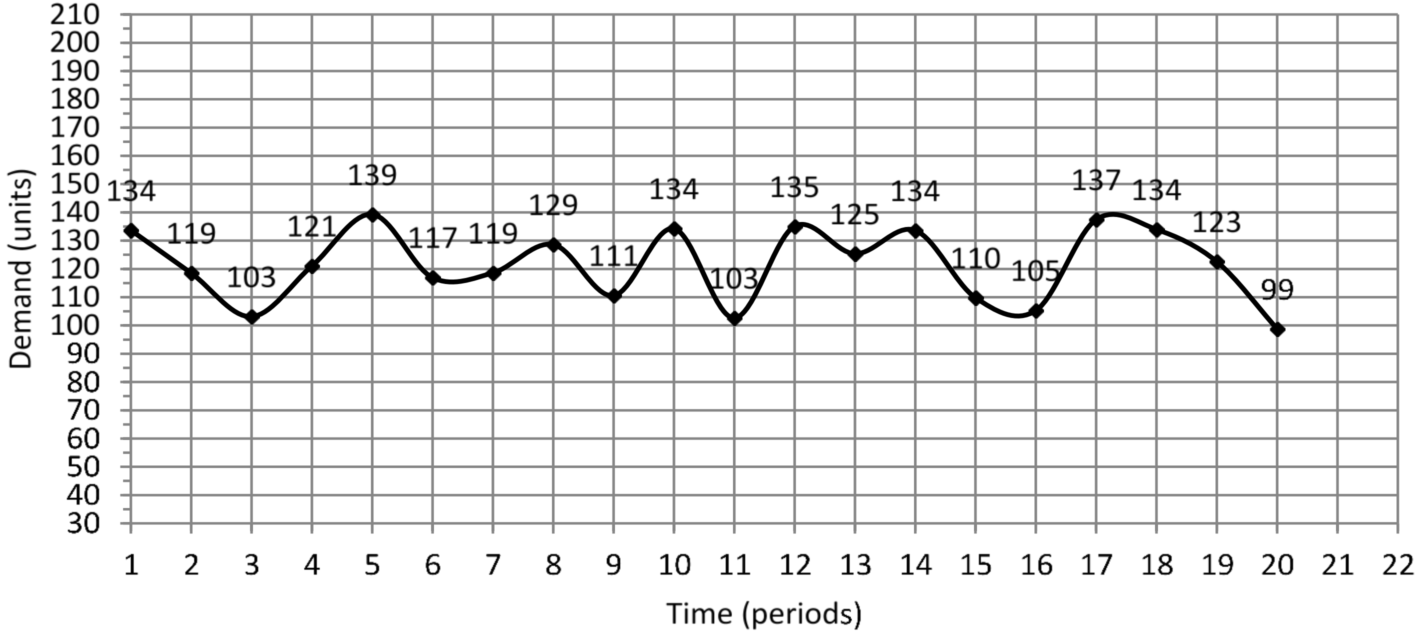
PRODUCT K



Sample form Group 3

Scenario A:

Product K, a mobile phone with multifaceted functionality, has extremely stable demand. It has got all that is necessary to compete very successfully in its target market. It is an attractively designed phone with full-fledged features, and comes with a nicely positioned price and exceptionally encouraging promotion package. It regularly receives exceedingly positive comments in the industry magazines/websites and first-class feedback from customers. Given the recent economic conditions, we strongly expect even higher demand for this product in the periods to come.

Scenario B:

This product has been serving its purpose and target market for a long time. Its customers seem to be satisfied with it and its sales performance is stable within a band. It could have continued like this for some time. However, our company has been experiencing vital problems with a major supplier, which happens to be the producer of a key part for this model. If this dispute cannot be solved shortly, we certainly will not be able to produce Product K until we find another supplier with equally good credentials. While it is very difficult to replace the existing one, it will certainly take some time until (a) we find such a supplier, and (b) it starts delivering the required parts. If customers learn about this problem, there is a very high possibility that we will be faced with significantly lower demand in the next period.

Sample form Group 3

YOUR FORECAST :

What is your ***point forecast*** for period 21 : ………………

What is your confidence (probabilistic estimate) that

the realized value would be within ± 5% of your point forecast: ……………… (between 0% and 100%)

YOUR PRODUCTION DECISION

How many units will you order for production? ……………… (between 0 and 750)

(Please note that *total production capacity* for period 21 is 750 units. Therefore your production orders for all six products should add up to a maximum of 750. Please keep in mind that there are different costs associated with over-production vs. under-production and make your decisions accordingly. Please use the checklist in the end for production plans)

Findings – The time-series for product demands

- Artificially created to control the levels of *uncertainty* and *trend* - similar to previous studies on judgmental forecasting (e.g. Gönül, Önkal & Lawrence, 2006; Önkal, Gönül & Lawrence, 2008; Önkal, Sayım & Gönül, 2013)

- Six **untrended** series, half with *high noise* and half with *low noise*

$$y(t) = 125 + error(t) \qquad t = 0,1,\ldots\ldots, 20$$

- *error*(t) was ***normally*** distributed with zero mean and a standard deviation of
  - 10% (i.e., 0.1 x 125 = 12.5) for low noise
  - 20% (i.e., 0.2 x 125 = 25) for high noise

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Findings – Accuracy of Point Forecasts

Group	No. of participants	MAE	SD
Group 1 - No scenarios	23	16.88	7.60
Group 2 - Weak scenarios	23	24.27	6.98
Group 3 - Strong scenarios	22	23.37	8.81

- Statistically produced forecasts (by *Forecast Pro*) on the series had **MAE** = 10.67
- So the software's forecasts were substantially ***more accurate*** than those produced by human judgment.

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Findings – Calibration of Confidence Assessments

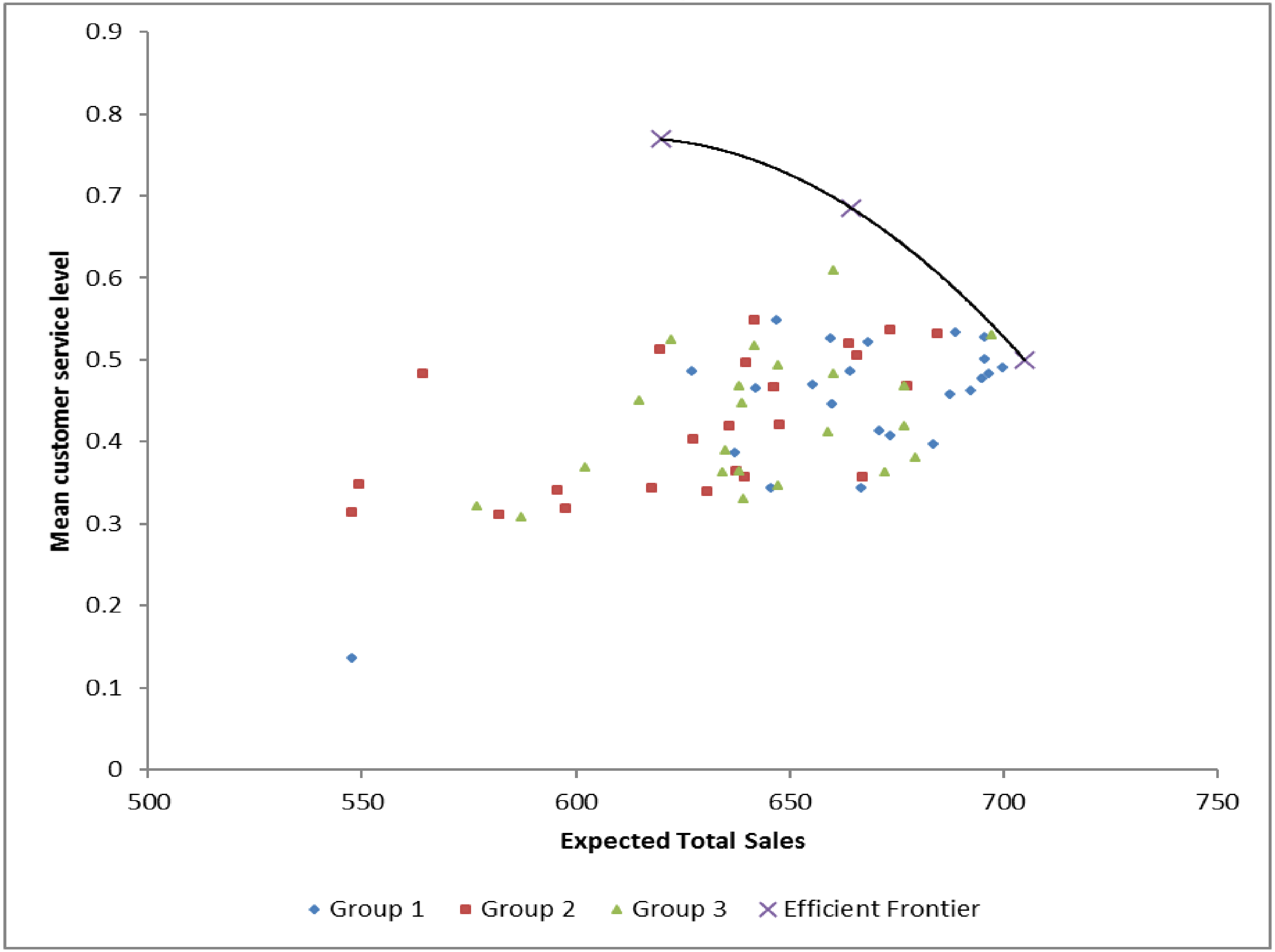
Bias = True SD – Implied estimate of SD (from Confidence assess.)

Group	Mean Bias (low noise)	SD	Mean Bias (high noise)	SD
Group 1 - No scenarios	7.66	1.40	19.60	1.43
Group 2 - Weak scenarios	6.96	3.43	18.66	4.24
Group 3 - Strong scenarios	7.11	2.00	19.66	1.77

- Almost all variability estimates were **too low** compared to true levels of variation – suggesting **overconfidence**.
- Statistically similar across all groups

Findings – Production Decision Quality

- Mean customer service levels *(% of demand that could be fulfilled*) across the products *vs.* the expected level of total sales in week 21.



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Findings – Production Decision Quality

- Mean <u>customer service levels</u> *(% of demand that could be fulfilled)* across the products *vs.* the <u>expected level of total sales</u> that in week 21.

Group	Mean service level	Expected total sales (units)
Group 1 - No scenarios	44.90%	665.2
Group 2 - Weak scenarios	42.20%	628.4
Group 3 - Strong scenarios	42.60%	642.9

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Discussion – Main Findings

- *Providing scenarios* to judgmental forecasters **worsened** forecast accuracy.
- *Judgmental point forecasts* of future demand (with or without scenarios) were **less accurate** than *software produced ones*
- Judgmental forecasters perceived *the demand variability* to be **much lower** than its true value – demonstrating **overconfidence**
- Scenarios **did not reduce** the tendency of forecasters to be *overconfident*.
- The *production level decisions* had a **greater deviation** from **optimality** when they also received *best-case and worst-case scenarios*.

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Discussion – What Next?

- These findings raise two questions
  - Why were *many of the decisions* **so far** from *the efficient frontier*?
    - Was this due to **inaccurate point forecasts**?
    - Was this due to **underestimation** of the **variance** of the probability distribution of demand?
    - Was this due to an **inability to handle** the need to **allocate** the total units of production capacity?
  - Why did those who *did not receive scenarios* make *'better'* decisions?

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THANK YOU

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